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TITLE

PLASTIC SUBSTRATE, FABRICATION METHOD THEREOF AND DEVICE USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to organic electroluminescent devices (OLEDs), and more particularly to a plastic substrate for OLED, fabrication method thereof, and device using the substrate.

Description of the Related Art

OLEDs are known to be highly efficient and capable of producing a broad band width of colors. Due to thin profile and wide viewing angle, OLED applications are variable and can be used as flat-panel displays. In order to achieve flatness, transparency, and high fabrication temperature tolerance, glass is a common choice for substrates. Current trends move toward light weight, slim profile, and even display on non-flat surfaces. Therefore, soft and flexible displays are currently being developed to replace glass substrates.

In order to achieve the above objects, flexible plastic (polymer) substrates have been developed for OLED, such as polycarbonate (PC), polyethylene terephthalate (PET) and polyimide but these polymer substrates have some disadvantages.

Polymer temperature tolerance is too low for fabrication, with maximum PC temperature about 129°C and PE

about 120°C. As well, polymers exhibit poor resistance to ambient humidity and oxygen penetration. Finally, PC and PET plastic substrates have difficulty achieving optical flatness and cannot be polished by chemical mechanical polishing. Thus, in conventional technology, soft and flexible plastic substrate cannot replace glass. To address the problem of OLED luminescent materials being easily damaged by ambient humidity and air penetration, addition of an encapsulation layer is conventionally employed. As disclosed in U.S. Pat. No. 5,855,994, an encapsulation layer is formed by coating flowable silicon oxide on the anode, then using UV light to solidify the encapsulation layer or a roller to press the silicon oxide film onto the anode. However, the additional encapsulantion layer is both costly and time-consuming. Additionally, the disclosed encapsulant process fails to address the stated problems of temperature intolerance and insufficient planarity.

SUMMARY OF THE INVENTION

Thus, an object of the invention is to provide a plastic substrate for OLED, and method of fabrication thereof, meeting requirements of high processing temperature tolerance, resistance to ambient humidity and oxygen penetration, and good surface planarity, on a flexible surface with transparency required for OLED formation.

Another object of the present invention is to provide an OLED device using the inventive substrate.

Accordingly, the present invention provides a plastic substrate with a deposition film of predetermined thickness formed thereon. The deposition film is formed by plasma CVD

with a formula of $SiO_eC_aH_bX_cY_dZ_f$ ($e\leq 2$, $2-e=a+b+c+d+f$), wherein X, Y and Z are periodic table IA, IIA, IIIA, IVA, VA, VIA or VIIA elements excepting H. X, Y and Z also can be selected from the group consisting of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Pd, Ag, Pt and Au. The OLED plastic substrate has both glass and plastic properties, allowing it to solve the above-mentioned problems. The glass properties provide high temperature tolerance, good gas and liquid resistance, superior planarity, and high transparency, whereas the plastic properties provide high flexibility. In addition, the deposition film has and encapsulated function, allowing OLED encapsulation fabrication to be omitted, such that the fabrication efficiency is improved.

The present invention also provides a method for fabrication of a plastic substrate for OLED, comprising providing a plastic substrate, and using plasma CVD to form a deposition film of predetermined thickness thereon, wherein the deposition film has a formula of $SiO_eC_aH_bX_cY_dZ_f$ ($e\leq 2$, $2-e=a+b+c+d+f$), wherein X, Y and Z are periodic table IA, IIA, IIIA, IVA, VA, VIA or VIIA elements excepting H. X, Y and Z also can be selected from the group consisting of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Pd, Ag, Pt and Au. By the above fabrication method, a plastic substrate for OLED featuring high temperature tolerance, good gas and liquid resistance, superior planarity, and high transparency and flexibility is obtained.

The present invention also provides an OLED using the plastic substrate, comprising a cathode and anode, with at

least one organic layer therebetween, a first plastic substrate beneath the cathode, and a second plastic substrate of the inventive structure above the anode. When a voltage is applied on the cathode and anode, the organic layer emits light.

DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, reference is made to a detailed description to be read in conjunction with the accompanying drawings, in which:

Fig. 1a and Fig. 1b show a fabrication process of the plastic substrate for OLED according to the first embodiment of the present invention.

Fig. 2 is a cross-section of the OLED structure according to the second embodiment of the present invention.

REFERENCE NUMERALS IN THE DRAWINGS

10 plastic substrate
20 deposition film layer
30 plastic substrate for OLED & second plastic substrate
40 anode
50 hole transport layer
60 electroluminescent layer
70 electron transport layer
80 cathode
90 first plastic substrate
100 organic layer

DETAILED DESCRIPTION OF THE INVENTION

In order to understand the above and other objects, characteristics and advantages, two preferred embodiments of the present invention are now detailed described with reference to the attached figures.

Fig. 1(a) and Fig. 1(b) show a fabrication process of an OLED plastic substrate comprising providing a plastic substrate 10 and using plasma CVD to form a deposition film layer 20 of a predetermined thickness thereon. The plastic substrate 10 and the deposition film layer 20 constitute a plastic substrate for OLED.

The plastic substrate 10 is formed with polycarbonate (PC), polyethylene terephthalate (PET), polyimide, polyester, or combinations thereof, although the present invention is not limited thereto. The deposition film layer 20 has a SiOeCaHbXcYdZf ($e \leq 2$, $2-e=a+b+c+d+f$) formula, wherein X, Y and Z are other than O, C is hydrogen, and X, Y and Z are periodic table IA, IIA, IIIA, IVA, VA, VIA or VIIA elements excepting H. X, Y and Z also can be selected from the group consisting of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Pd, Ag, Pt and Au. The deposition film layer 20 is hereinafter referred to as PolySOX layer.

Because the deposition film layer 20 is formed by plasma CVD, free radicals in plasma produce 20~30Å interface covalent bonds between the deposition film layer 20 and the plastic substrate 10, so that the two layers bond tightly.

The planar deposition layer thickness is in a range of about 0.1~4.5μm. If the thickness is less than 0.1μm, the

deposition film layer 20 cannot block ambient humidity, oxygen, or other gas, and cannot accept CMP for full planarization, also, if the thickness exceeds 4.5μm, the layer cracks easily.

In addition, the PolySOX layer has Si-O-Si bonds that provide more freedom than rigid Si-Si bonds due to the oxygen presence. Therefore, the PolySOX layer provides not only rigidity of Si-Si bonds, but also the flexibility and high temperature tolerance of Si. Furthermore, Si-O-Si bonds provide transparency of 97% or more.

An OLED using the plastic substrate of the present invention is also disclosed, with reference to Fig. 2.

In Fig. 2, the OLED using the first embodiment plastic substrate comprises a first plastic substrate 90, an anode 40, a hole transport layer 50, an electroluminescent layer 60, an electron transport layer 70, a cathode 80 and a second plastic substrate 30 comprising the inventive structure.

The hole transport layer 50, electroluminescent layer 60 and electron transport layer 70 constitute organic layer 100. The electron transport layer 70 is near the cathode and the hole transport layer 50 is near the anode. The electroluminescent layer 60 is between the hole transport layer 50 and the electron transport layer 70.

Thus, the invention provides a plastic substrate structure for OLED that overcomes the limitations and problems of the existing technology, meeting requirements of high processing temperature tolerance, resistance to ambient humidity and oxygen penetration, and good surface planarity,

on a flexible surface with transparency required for OLED formation.

While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.